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OXY-ACETYLENE WELDING AND CUTTING

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1. INTRODUCTION.

1.1 Oxy-acetylene welding is a term applied to welding processes in which the source of heat is supplied by the combustion of acetylene with oxygen. The welding processes described in this paper are the fusion welding process, and the braze welding (or bronze welding) process.

1.2 In the fusion welding process, the oxy-acetylene flame is used to melt the metal portions being joined (called the "base" or "parent" metal) so that a molten pool is formed which solidifies on cooling to form a strong join between the two sections. Additional metal, in the form of a filler rod is melted and added to build up the join to the required level. The filler rod is of similar metal to the base metal. The fusion welding process has many applications, one of which is the attachment of foot plates to steel poles.

1.3 Braze welding, which is often referred to as bronze welding, differs from fusion welding in that the base metal is not heated to its melting point, but usually only to a dull red heat. In this method, the joint preparation is similar to that used for fusion welding but the filler rod is of different metal to the metals being joined.

1.4 Another joining process known as "brazing" (not to be confused with braze welding) is also described in this paper. This is not strictly a welding process but is included as it is performed by a welder using the oxy-acetylene equipment. It is used for joining metal components where the joints are such that a thin film of molten filler metal will flow by capillary action into the space between the sections.

1.5 Oxy-acetylene cutting is a process in which the metal to be cut is heated by the oxy-acetylene gas mixture, and a stream of pure oxygen is applied which combines with the iron to form iron oxide. The section of metal to which the flame is applied is burnt away in the form of a scum, which is referred to as "slag". This process is used to cut holes in steel poles or to cut a section from these poles.

1.6 This paper describes the equipment, and the method of using it for welding, brazing and cutting.

E.T.S. 13/0127

2. GASES AND CYLINDERS.

2.1 OXYGEN is an odourless, colourless gas, is non-flammable but has the property of vigorously supporting and accelerating combustion, hence its value to the welding industry. It is compressed to a pressure of approximately 13 000 kPa into steel cylinders (Fig. 1(a)). Oxygen cylinders are painted black and are fitted with a right-hand threaded outlet. The valve, in the outlet is controlled by a key which fits onto a square spindle in the valve. The most commonly used oxygen cylinder holds 7 m^3 of gas under pressure.

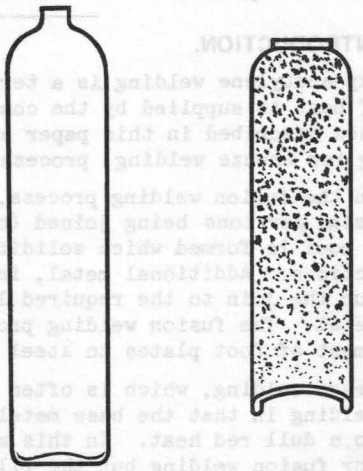
2.2 ACETYLENE is a highly flammable gas, colourless and has a characteristic odour. When mixed with oxygen it produces the highest known flame temperature of any two gases.

Acetylene in its free state cannot be compressed safely above about 100 kPa, therefore to provide for transport of this gas in large quantities it is necessary to use a steel cylinder (Fig. 1(b)) filled with a porous material saturated with liquid acetone, into which the acetylene is dissolved.

When acetylene is forced into the cylinder it comes in contact with the acetone in the small spaces, and as acetone has the property of absorbing many time its own volume of acetylene, it permits the storage of a greater quantity of acetylene than could normally be accommodated. The acetylene is not present in a free space, but is dissolved into the acetone at a pressure of approximately 1500 kPa at 15°C.

When the cylinder valve is opened slowly, the pressure in the cylinder falls and acetylene comes away from the liquid acetone. If the rate of flow is too great, the gas will not have time to separate from the acetone and the liquid will flow from the cylinder. Liquid acetone may also be discharged from the cylinder if the cylinder is left on its side.

Acetylene cylinders are painted maroon to distinguish them from other gas containers and have a left-hand threaded outlet for connection of fittings. A valve, similar to that on oxygen cylinders is located in the outlet. Acetylene cylinders are made in various sizes, e.g. 1.8 and 7 m^3. As a safety precaution four fusible metal plugs with a melting point between 100°C and 105°C are fitted - two in the base and two in the top of the cylinder.



(a) Oxygen. (b) Acetylene.

FIG. 1. CROSS SECTION OF CYLINDERS.

2.3 STORAGE AND HANDLING OF CYLINDERS. Gas cylinders, while containing gases at high pressures are quite safe if precautions as described are taken:

- Keep cylinders, whether full or empty, away from heat.
- Don't use a cylinder or its contents for other than its intended purpose, e.g. cylinders as supports or rollers; oxygen as a substitute for air etc.,
- Protect cylinder valves from bumps, falls, and weather.
- Don't move cylinders with fittings attached. Check that the valve is closed before removing fittings.

3. DESCRIPTION OF EQUIPMENT.

3.1 The flame used for oxy-acetylene welding and cutting is fed by a mixture of acetylene and oxygen at various pressures depending on the class of work being done.

To facilitate the control and mixing of the gases for the flame the following items of equipment are necessary:

- Regulators - one for each cylinder.
- Tubing - for connecting regulators to blowpipe.
- Blowpipe (fitted with tip or nozzle).

3.2 **REGULATORS** are devices for controlling the delivery of oxygen and acetylene at a chosen constant pressure regardless of changes in the cylinder or hose pressures.

A regulator consists of a metal body containing valves, springs, etc., to which are attached two gauges and spigots for connecting the regulator to the cylinder and for connecting a hose to the regulator.

One gauge is called the high pressure gauge and is provided to indicate the pressure of gas in the cylinder. The other gauge is the low pressure gauge and shows the pressure of the gas after it has been reduced by the regulator. An adjusting knob (or tee-screw) is provided on the regulator to adjust the pressure.

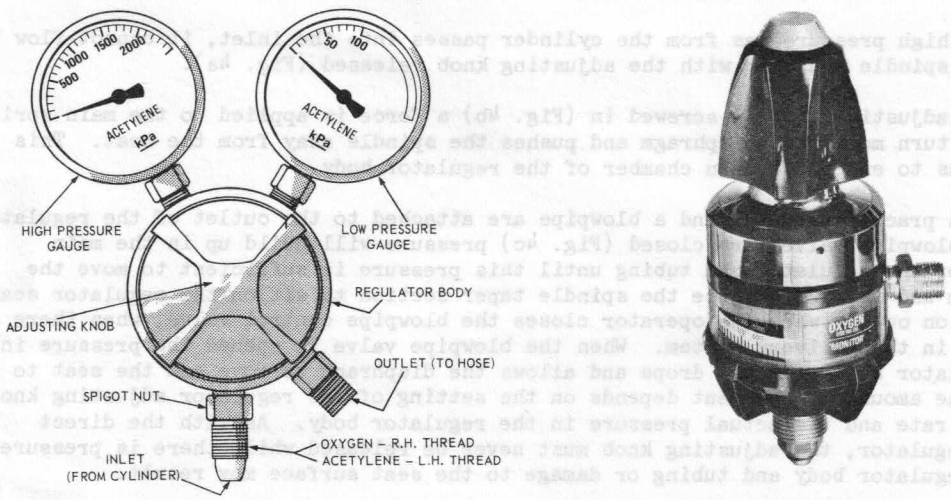
To assist in correct identification of regulators they are coloured to conform with the colour scheme of the cylinders - black for oxygen and maroon for acetylene.

The oxygen regulator has a right-hand threaded spigot for attaching to the cylinder while the acetylene regulator has a left-hand threaded spigot.

Fig. 2(a) shows a typical acetylene regulator. Note that the low pressure gauge is calibrated to 100 kPa which is the maximum safe discharge pressure for 'free' acetylene gas.

An oxygen regulator is similar to the acetylene regulator except that the gauges are calibrated to higher pressures e.g. 20 000 kPa on the high pressure gauge and 800 kPa on the low pressure gauge.

The latest style of regulator with built-in gauges is shown in Fig. 2(b). These are available for oxygen or acetylene and contain a two-piece revolving scale on which the high and low pressures are recorded.



(a) Common. (b) Streamlined.

FIG. 2. TYPICAL REGULATOR STYLES.

Regulators are of two general types - the *direct acting* and *inverse acting* types.

The *direct acting* regulator (Fig. 3) has a nozzle type valve on which the inlet pressure acts directly, tending to open it. The valve seat is attached to the metal diaphragm, which is preset to ensure that when the regulator spring is released the seat is pressed on to the regulator nozzle. When the high pressure gas from the cylinder passes into the inlet arm it cannot enter the regulator body if the adjusting knob (or tee-screw) is released. (Fig. 3a).

When the adjusting knob is screwed in, a force is applied through the spring, which in turn deflects the diaphragm. This movement of the diaphragm lifts the seat from the nozzle and allows gas to enter the regulator body (Fig. 3b).

When tubing and a blowpipe are attached to the regulator outlet and the blowpipe valves are closed (Fig. 3c), pressure builds up in the regulator body and tubing until the pressure on the inside of the regulator body and on the diaphragm is sufficient to restore the diaphragm to its original position. The seat is then forced to close (Fig. 3c). This action occurs every time an operator closes the blowpipe control valves, when there is pressure in the delivery system.

When the blowpipe valve is opened (when blowpipe is alight) the pressure drops in the regulator body and tubing, and allows the diaphragm to move and the seat to open. The amount of movement depends on the setting of the adjustor knob, the flow rate of the gas and the actual pressure in the regulator body. In practice this amount of movement is very small.

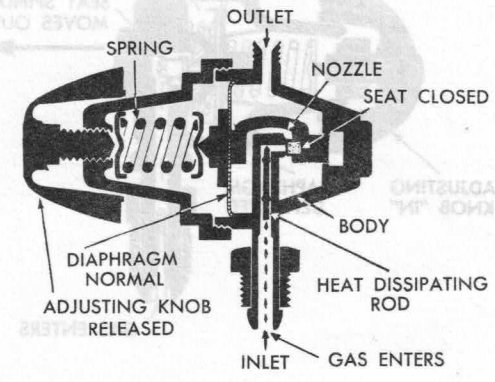
The adjusting knob should never be released while there is pressure in the regulator body and tubing (Fig. 3d). Damage to the valve seat may result as the balancing force normally exerted by the spring is withdrawn, thus leaving the seat forced against the inlet nozzle. To avoid this, the cylinder valve must be closed and the gases released at the blowpipe valves before the adjusting knob is released.

The *inverse acting* regulator (Fig. 4) has a stem type valve with the inlet pressure acting on the base, tending to close it. The valve assembly is held in place in the regulator body by the back plug (Fig. 4a). A nylon sleeve which fits over the metal valve spindle makes contact with the brass seat. The spindle screws into the diaphragm which has a light spring between it and the regulator body to ensure shut-off when the adjusting knob is released.

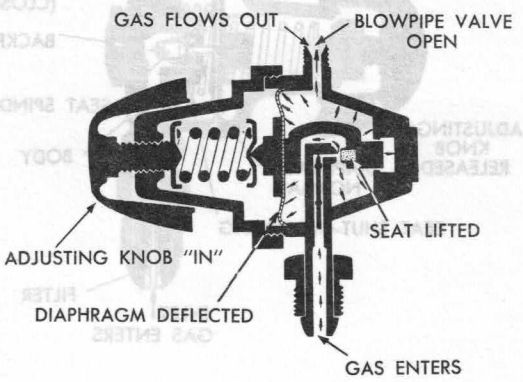
When the high pressure gas from the cylinder passes into the inlet, it cannot flow past the spindle and seat with the adjusting knob released (Fig. 4a).

When the adjusting knob is screwed in (Fig. 4b) a force is applied to the main spring which in turn moves the diaphragm and pushes the spindle away from the seat. This allows gas to enter the main chamber of the regulator body.

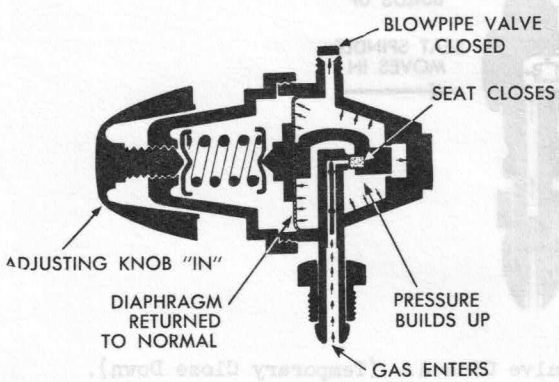
If, as in practice, tubing and a blowpipe are attached to the outlet of the regulator and the blowpipe valves are closed (Fig. 4c) pressure will build up in the main chamber of the regulator and tubing until this pressure is sufficient to move the diaphragm and this will force the spindle taper section to sit on the regulator seat. This action occurs when the operator closes the blowpipe control valve, when there is pressure in the delivery system. When the blowpipe valve is opened the pressure in the regulator body and hose drops and allows the diaphragm to move and the seat to open. The amount of movement depends on the setting of the regulator adjusting knob, the flow rate and the actual pressure in the regulator body. As with the direct acting regulator, the adjusting knob must never be released while there is pressure in the regulator body and tubing or damage to the seat surface may result.



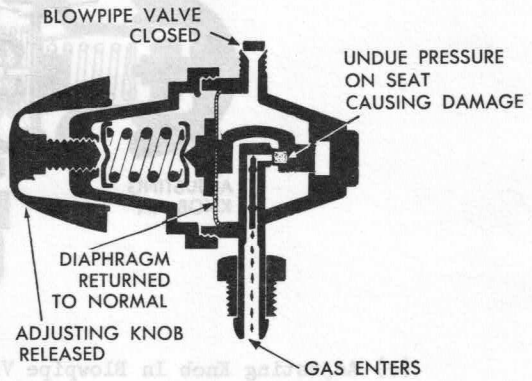
(a) Normal Condition Adjusting Knob Out.



(b) Adjusting Knob In Blowpipe Valve Open. (Equipment In Use).

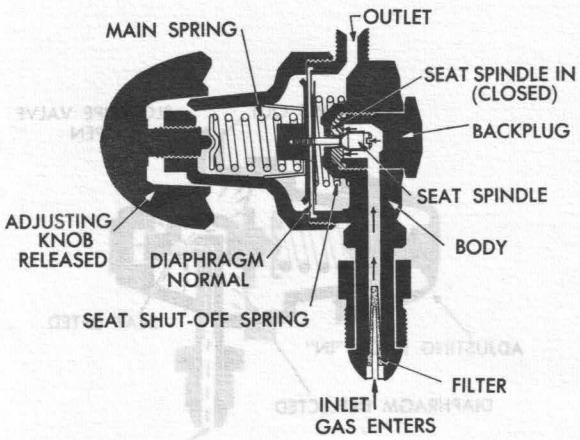


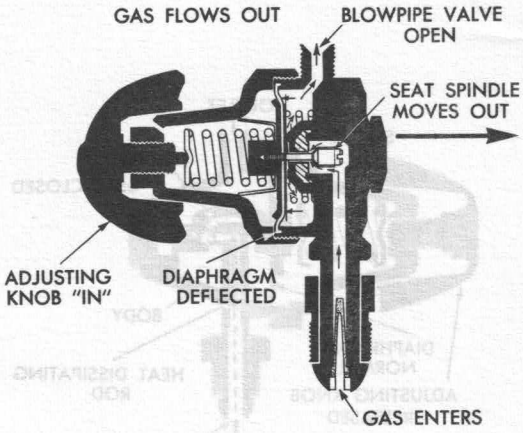
(c) Adjusting Knob In Blowpipe Valve Closed. (Temporary Close Down).



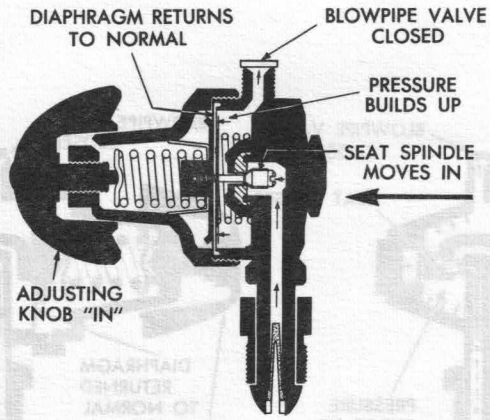
(d) Adjusting Knob Out Blowpipe Valve Closed. (Incorrect - Causes Damage).

FIG. 3. OPERATION OF DIRECT ACTING REGULATOR.





(a) Normal Condition Adjusting Knob Out. (b) Adjusting Knob In Blowpipe Valve Open. (Equipment In Use).



(c) Adjusting Knob In Blowpipe Valve Closed. (Temporary Close Down).

FIG. 4. OPERATION OF INVERSE ACTING REGULATOR.

THE TWO STAGE OXYGEN REGULATOR (Fig. 5) consists of an inverse acting regulator (single stage) with a "first stage capsule" fitted into the back of the regulator body. The two stage regulator is virtually two single stage regulators linked together except that the first stage has a fixed pressure setting which reduces the cylinder pressure to an intermediate pressure of 2400 kPa. This reduced pressure then becomes the inlet pressure to the second stage of the regulator, where it is reduced to the required working pressure by the adjusting knob as in the case of the single stage regulator.

The two stage oxygen regulator gives a more accurate control of pressures because the first stage maintains a constant inlet pressure to the second stage.

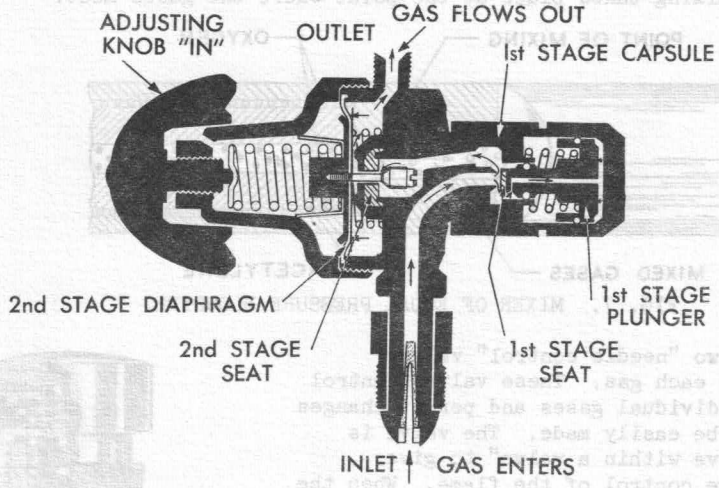


FIG. 5. TWO STAGE OXYGEN REGULATOR SHOWING GAS FLOW.

TO PREVENT DAMAGE TO REGULATORS observe these rules:

- Always "crack open" cylinder valves. (See para. 4.1).
- Allow the regulator to turn with spigot nut when finally tightening.
- Make sure the adjusting knob is released before turning on the cylinder valve.
- Open the cylinder valve slowly and carefully when a regulator is attached.
- Never release the adjusting knob when pressure is shown on the delivery or output gauge.
- Never attempt to repair regulators.

3.3 TUBING. The tubing is of rubber and canvas construction and is designed to withstand high pressures while providing flexibility to give the operator freedom of movement. As the tubing contains gas under pressure care must be taken to protect it from damage and to replace it if damaged or worn.

The tubing connecting the *oxygen* supply to the blowpipe is *black* in colour while the *acetylene* tubing is *red*.

3.4 THE BLOWPIPE is a device for bringing together and properly mixing acetylene gas and oxygen in such a way that the mixture when ignited produces a flame that can be controlled.

The blowpipe for general use is the equal pressure or mixer type (Fig. 6). It may be fitted with various sized "tips" for welding or may be converted for cutting by fitting a cutting attachment. This blowpipe operates on equal pressures of oxygen and acetylene within a range of 35 to 100 kPa.

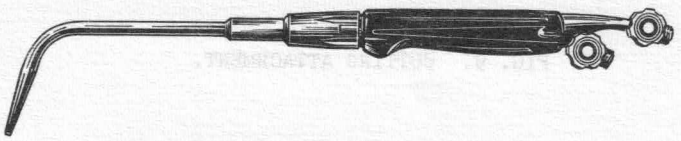


FIG. 6. BLOWPIPE FITTED WITH WELDING TIP.

Fig. 7 shows the working principles of the equal pressure blowpipe in which the acetylene is fed through a centre port, while the oxygen enters from a surrounding narrow passage. Mixing takes place at the point where the gases meet.

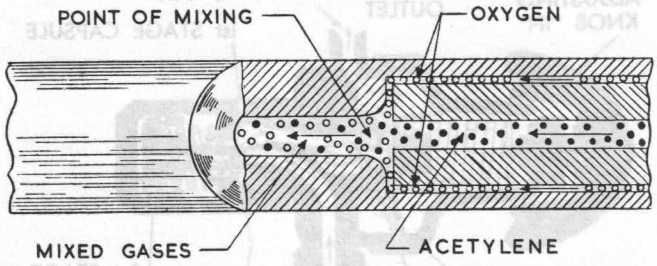


FIG. 7. MIXER OF EQUAL PRESSURE BLOWPIPE.

The blowpipe has two "needle control" valves (Fig. 8) - one for each gas. These valves control the flow of the individual gases and permit changes of flame types to be easily made. The valve is designed as a "valve within a valve" to give extremely sensitive control of the flame. When the control is operated, the small inner valve is opened and the large valve is held closed by spring tension until the small valve is completely opened.

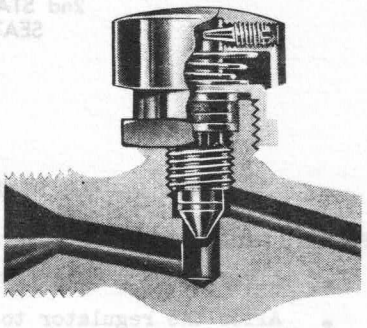


FIG. 8. NEEDLE CONTROL VALVE.

3.6 CUTTING ATTACHMENT (FIG. 9). The cutting attachment for use with the equal pressure blowpipe differs from the welding tip in that provision is made for a supply of cutting oxygen to the flame in addition to the oxygen mixed with the acetylene for the heating flame. The cutting oxygen is controlled by a lever which operates a valve in the cutting oxygen feed. The oxygen for the heating flame is controlled by a valve on the cutting attachment after the normal blowpipe oxygen valve is opened.

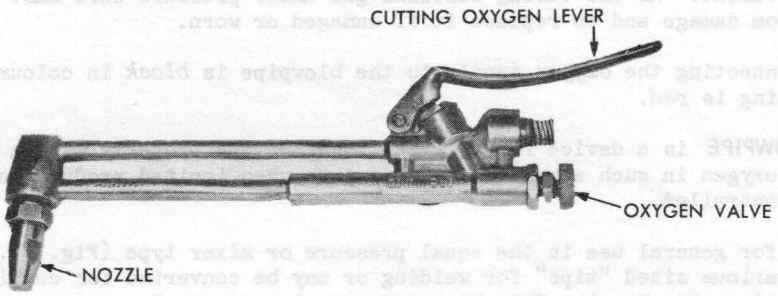


FIG. 9. CUTTING ATTACHMENT.

Where heavier cutting than can be handled by the cutting attachment is to be done a cutting blowpipe is used. (Fig. 10). This blowpipe has a slightly different arrangement of ports - in this case provision is made for a separate oxygen feed to the cutting nozzle for the supply of cutting oxygen.

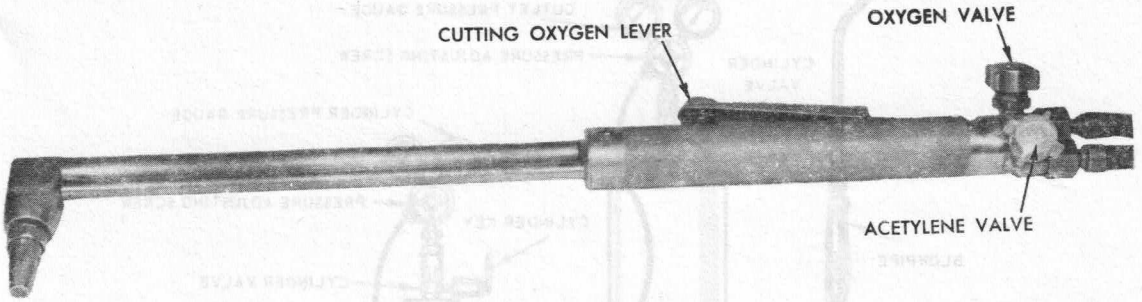


FIG. 10. CUTTING BLOWPIPE.

4. SET-UP AND OPERATION OF EQUIPMENT.

4.1 The procedure described below refers to the setting up of oxy-acetylene equipment consisting of cylinders, regulators, tubing, equal pressure blowpipe, and welding tip (or cutting attachment).

STEP 1. "Crack open" the cylinders i.e. sharply open each cylinder valve one quarter of a turn allowing the escaping oxygen and acetylene to blow out any dust or grit which could damage the regulators.

OBSERVE THESE PRECAUTIONS!

- Never let oil or grease come into contact with oxygen or any equipment through which oxygen passes. Oil and grease may ignite violently in the presence of oxygen under pressure.
- Do not open an acetylene cylinder near other cutting or welding work, or near sparks, flame or any other possible source of ignition.
- Always leave the key in place on the acetylene cylinder while the cylinder is in use, so that it may be turned off quickly in an emergency.

STEP 2. Attach the regulators to the respective cylinders and tighten the spigot nuts. Allow each regulator to turn with its spigot nut when finally tightening to the cylinder.

STEP 3. Make sure adjusting knobs (or tee-screws) on regulators are released. Open each cylinder valve very slowly, so that the hands of the high pressure gauges move up gradually. Never open the cylinder valves more than 1½ turns.

STEP 4. Attach the black oxygen tubing to the oxygen regulator outlet and the red acetylene tubing to the acetylene regulator outlet.

STEP 5. Screw the adjusting knobs of both regulators in to blow a little oxygen and acetylene through the tubing to remove french chalk, dust, etc.. Release adjusting knobs.

STEP 6. Attach the other end of the black tubing to the blowpipe oxygen inlet valve which is marked "O". Attach the other end of the red tubing to the blowpipe acetylene inlet valve marked "A".

Check that blowpipe valves are closed. Attach a welding tip of the required size (or the cutting attachment).

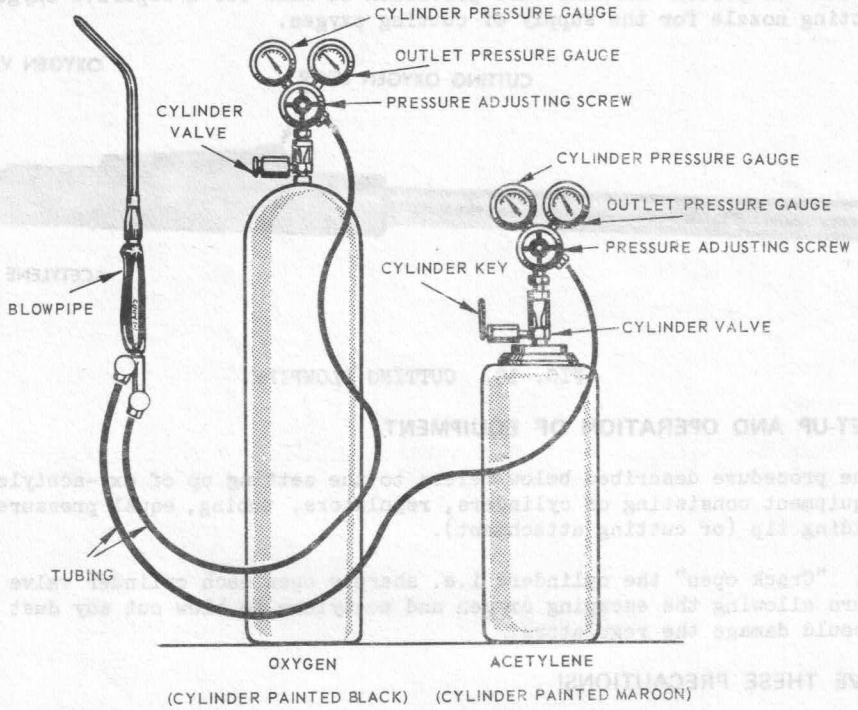


FIG. 11. EQUIPMENT ASSEMBLED.

4.2 TESTING EQUIPMENT FOR LEAKS. Leaks in oxy-acetylene equipment are a danger to you, your workmates and your equipment. Loose connections are the cause of most leaks and can usually be stopped by tightening the connections.

When connecting the equipment to a new cylinder always make the following tests before lighting up:-

- Shut off the oxygen blowpipe valve.
- Open the oxygen cylinder valve and set the regulator to show approximately 100 kPa on the delivery gauge.
- Close the oxygen cylinder valve.
- Watch the oxygen cylinder gauge. Any decrease in pressure means a leak in the oxygen system. If there is no pressure drop there are no leaks up to the blowpipe valve.
- Do the same tests on the acetylene system.

4.3 **LOCATE LEAKS** with a clean paint brush, a bucket of water and soft soap to make a soapy water mixture.

CHECK THE OXYGEN SYSTEM including the blowpipe past the control valves, by doing the following:

- Close the acetylene cylinder valve and release all acetylene from the regulator, tubing and blowpipe.
- Disconnect the acetylene tubing from the blowpipe and close the blowpipe acetylene valve.
- Open the oxygen cylinder and blowpipe valves.
- Turn the oxygen regulator adjusting knob until the delivery gauge shows a pressure of 100 kPa.
- Place your thumb over the blowpipe tip to stop the flow.
- Apply soapy water to the points marked in Fig. 12.
- Test the tubing by running it through a bucket of water.
- Test the blowpipe valve by closing it and placing the tip in water.

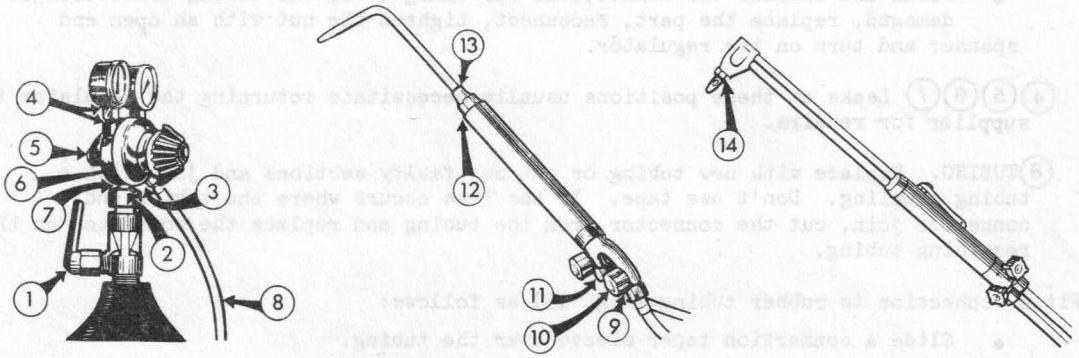


FIG. 12. POSSIBLE LEAK LOCATIONS.

CHECK THE ACETYLENE SYSTEM up to the blowpipe control valve as follows:

- Close the oxygen cylinder valve and release all oxygen from the regulator, tubing and blowpipe.
- Disconnect the oxygen tubing from the blowpipe and close the blowpipe oxygen valve.
- Test the acetylene system in the same way as the oxygen system.

There is no need to repeat the test for leaks in the *blowpipe;* as this has been checked in the oxygen system test.

4.4 STOPPING LEAKS. Most of the leaks in the equipment can be repaired simply, but if there is damage to the equipment it will be necessary to return the component to the supplier for repair or replacement. The simply repaired leaks are listed below, together with the action to be taken in each case. The number of each leak is as shown in Fig. 12.

(1) CYLINDER VALVE GLAND.

- Close the cylinder valve.
- Tighten the gland packing nut.
- Open the valve and test again.

(2) REGULATOR CYLINDER VALVE CONNECTION.

- Close the cylinder valve.
- Disconnect the regulator.
- Clean and examine all connections for damage. If the regulator or the cylinder is damaged, return to the supplier.

(3) REGULATOR TUBING CONNECTION.

- Shut off the regulator.
- Disconnect the tubing.
- Clean and examine the connections for damage. If the tubing connection is damaged, replace the part, reconnect, tighten the nut with an open end spanner and turn on the regulator.

(4)(5)(6)(7) Leaks at these positions usually necessitate returning the regulator to supplier for repairs.

(8) TUBING. Replace with new tubing or cut out faulty sections and join with a tubing coupling. Don't use tape. If the leak occurs where the tubing and connector join, cut the connector from the tubing and replace the connector on the remaining tubing.

Fit a connection to rubber tubing (Fig. 13) as follows:

- Slide a connection taper sleeve over the tubing.
- Attach the nut and nipple to the blowpipe inlet connection.
- Hold the taper sleeve on the tubing firmly with one hand and screw the blowpipe, with nut and nipple attached, into the sleeve and tubing.

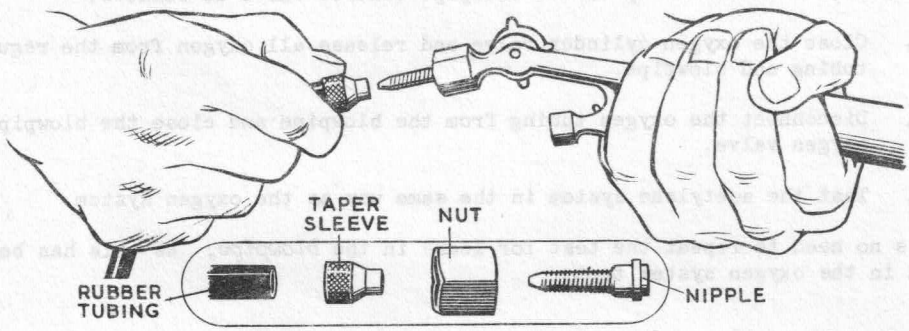


FIG. 13. FITTING A CONNECTION TO TUBING.

(9) BLOWPIPE TUBING CONNECTIONS.

- Shut off the oxygen or acetylene at the regulator.
- Remove the blowpipe hose connection and clean it. Renew if damaged.
- Tighten the nut with an open end spanner.

(10) BLOWPIPE VALVE GLAND. Tighten the valve gland nut with an open end spanner. If this does not remove the fault, replace the gland washer.

(11) BLOWPIPE VALVE SEAT. If bubbles emerge from the end of the tip or nozzle when it is placed in water, the gas is not completely shut off at the blowpipe valves.

- Shut off oxygen (or acetylene) at the regulator.
- Take the valve apart; clean the end of the valve stem and the seat of the valve body.
- If there is any damage return the equipment to the supplier for repairs.

(12) BLOWPIPE HANDLE AND MIXER CONNECTION.

- Shut off the oxygen and acetylene valves, unscrew the fluted sleeve nut from the blowpipe handle and remove the mixer.
- Remove the circlip from the body of the mixer and slide the fluted sleeve nut forward.
- Examine the two "O" rings and replace if necessary.
- Re-assemble the blowpipe and if it still leaks, return it to the supplier for repairs.

(13) MIXER AND TIP OR BARREL CONNECTION.

- Tighten the tip into the mixer.
- If this does not stop the leak, examine the seating for faults. If still leaking return it to the supplier for repairs.

(14) BARREL AND CUTTING NOZZLE CONNECTION.

- Tighten the nozzle with an open end spanner.
- If the leak remains examine the nozzle and barrel seating for scores, and if necessary return it to the supplier for repairs.

4.5 ADJUSTING PRESSURES. After the equipment has been set up as in para. 4.1 and has been thoroughly checked for leaks the next step is to obtain the correct pressures of oxygen and acetylene for the particular job.

STEP 1. Open the acetylene blowpipe valve.

STEP 2. Screw in the acetylene regulator adjusting knob until the delivery gauge shows the required pressure.

STEP 3. Close the acetylene blowpipe valve.

Repeat Steps 1, 2 and 3 for oxygen.

4.6 ADJUSTING THE FLAME. Accurate flame adjustment is a most important factor in successful welding and cutting.

There are three types of flame - neutral, oxidising and reducing or carburising, the names arising from the effect of the flames on metal.

- THE NEUTRAL FLAME (Fig. 14) is produced when equal quantities of oxygen and acetylene are supplied by the blowpipe. It is characterised by an almost colourless outer envelope and a sharply defined inner cone. It is used for most fusion welding and cutting applications.

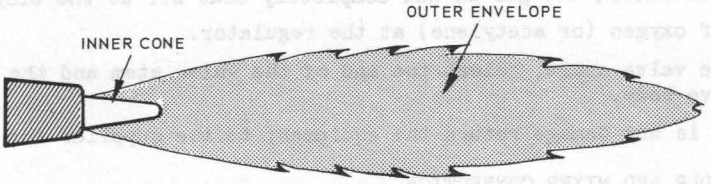


FIG. 14. NEUTRAL FLAME.

To obtain a neutral flame using a welding blowpipe and tip proceed as follows:

STEP 1. Open the blowpipe acetylene valve slightly and light with a flint lighter or pilot light.

STEP 2. Increase the acetylene until the flame is igniting just beyond the end of the tip, then decrease the acetylene until the flame is igniting at the end of the tip and little or no smoke is visible.

STEP 3. Open the blowpipe oxygen valve until the flame resolves itself into two visible sections, that nearest the tip being white and ragged and the other (inner cone) blue and feathery at first. Continue opening the oxygen valve until the inner cone becomes clearly defined, sky blue in colour and about 6 mm long.

To obtain a neutral flame using a standard cutting blowpipe (T 195 or similar) proceed as in Steps 1 to 3 then depress the cutting oxygen lever and check that the flame remains neutral. Should an acetylene feather appear, reduce the acetylene until it disappears.

To obtain a neutral flame when using the welding blowpipe and cutting attachment (T 156, TD 48 or similar), first open the blowpipe oxygen valve one full turn (heating oxygen valve on cutting attachment closed) then proceed as in Steps 1 and 2. Carry out Step 3, but in this case, use the heating oxygen valve on the cutting attachment to control the inner cone. Then check the flame with the *cutting* oxygen lever depressed.

- THE OXIDISING FLAME (Fig. 15) is produced when an excess of oxygen is contained in the flame. It is characterised by a shorter inner cone than that of the neutral flame. It is used for welding of brasses and bronzes.

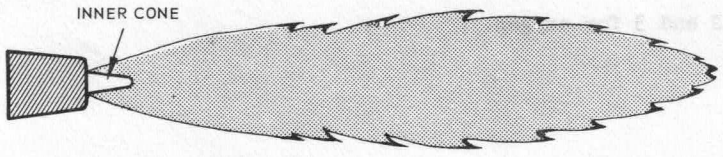


FIG. 15. OXIDISING FLAME.

To obtain an oxidising flame:

STEP 1. Obtain a neutral flame.

STEP 2. Increase the oxygen or decrease the acetylene until the inner cone becomes shorter, more pointed and bluish in colour. The amount of excess oxygen required for use of this flame on brasses and bronzes is determined by the influence of the flame on the molten metal and is adjusted to maintain a shiny surface on the "puddle".

- THE CARBURISING FLAME (Fig. 16) is produced when the flame contains an excess of acetylene. It is characterised by a luminous intermediate cone or acetylene "feather" caused by unburned carbon particles. The carbon particles "reduce" or remove oxygen from iron oxides which may be present in the welding of steel. This is the reason the flame is sometimes referred to as a "reducing" flame. This flame is used when welding some of the carbon steels, aluminium, bronze and nickel alloys, also when depositing a hard metal on a softer parent metal in the "hardfacing" process.

FIG. 16. CARBURISING FLAME.

To obtain a carburising flame:

STEP 1. Obtain a neutral flame.

STEP 2. Increase the acetylene or decrease the oxygen until a feather of the correct length is obtained. The amount of excess can be measured by the ratio of the length of the feather to the length of the inner cone of the neutral flame.

4.7 BACKFIRES AND FLASHBACKS. A *backfire* is the momentary extinguishing or momentary burning back of the flame into the blowpipe tip (or nozzle). This may happen if the tip is touched against the work, if particles enter the tip and obstruct the gas flow, or if the tip overheats.

Sometimes the trouble clears itself immediately, and if the work is hot enough the blowpipe will relight. If the blowpipe does not relight, close the blowpipe valves immediately.

Before relighting check the pressures and cool the tip or nozzle.

A *flashback* is the burning back of the flame into the blowpipe or the ignition of an explosive mixture in one of the gas lines. A flashback can burn right back into the tubing. It can be caused by improper pressures, distorted or loose tips or mixer seats, kinked hose, clogged tip or blowpipe holes or by an overheated tip, nozzle or blowpipe.

A flashback in the blowpipe is indicated by a flame burning at the mixer with a shrill hissing sound. If this happens:

- Close the blowpipe oxygen valve.
- Close the blowpipe acetylene valve. Allow a few moments for the flame to burn out.

If a flashback occurs in the tubing, close the cylinder valves at once.

If an acetylene cylinder becomes hot through a severe flashback (or is overheated accidently), close the valve, detach the regulator and take the cylinder outdoors, cool with plenty of water, then open the valve fully, still keeping the cylinder cool with water until it is empty. Leave it outside with the valve open and notify the supplier.

Flashbacks indicate that there is something wrong with the equipment. Before relighting check:

- Pressures - incorrect pressures can cause a flashback.
- Tubing - remove from the blowpipe and inspect for damage. If damaged, replace the entire length.

4.8 CLOSING DOWN. When closing down for a short period:

STEP 1. Close the blowpipe acetylene valve.

STEP 2. Close the blowpipe oxygen valve.

When closing down at the end of the job:

STEP 1. Close the blowpipe acetylene valve.

STEP 2. Close the blowpipe oxygen valve.

STEP 3. Close both cylinder valves.

STEP 4. Open the blowpipe oxygen valve and allow the gas to drain out. When both oxygen regulator gauges have fallen to zero, close the blowpipe oxygen valve.

STEP 5. Release the oxygen regulator adjusting knob.

STEP 6. Repeat Steps 4 and 5 with the acetylene valve and regulator.

4.9 PERSONAL SAFETY. For safe welding and cutting the following precautions must be observed:

- Maintain your equipment in good condition.
- Wear goggles with the correct shade of filter (lens) when using a blowpipe. Goggles protect the eyes against sparks and flying slag, strong light and injurious rays from the flame. As well as protecting the eyes, goggles enable you to see the work easier than with the naked eye.
- Wear suitable gloves, aprons, shoes and protective clothing.
- Take care that your clothing is not oily and your pockets and cuffs are not open to receive hot slag or sparks.
- Never use oxygen to dust off your clothing.
- Use a flint lighter or pilot light to light the blowpipe. Never use matches.
- When working on lead bearing materials, metal coated with lead paint, or any metals giving off toxic fumes, always use a suitable respirator.
- Never use a blowpipe when working on staging suspended by fibre rope.

4.10 FIRE PREVENTION. The oxygen acetylene flame itself is rarely the cause of fire, but sparks which fly from cutting or welding work can travel a long distance from the work and remain hot for some time. To guard against fire from sparks take these precautions:

- When welding or cutting near wooden floors, walls, etc., shield them with wet asbestos or sheet metal. If cutting over a wooden floor wet the floor down before starting to cut.
- Don't use wooden "horses" or boards to support welding or cutting work.
- Clear the area within a radius of 8 metres of all rubbish and flammable materials before starting to weld or cut.
- Always have equipment available to put out a fire.
- Keep flame, sparks and hot metal away from cylinders and tubing.
- Where possible, another man without safety goggles should keep the vicinity of work under observation.
- As heated combustible materials can smoulder before bursting into flame, the work area should be inspected 1 hour after work has ceased.

5. FUSION WELDING.

5.1 Before commencing to weld, an operator must know the type of material and must then:

- Decide which welding process is to be used.
- Prepare the edges of the material for welding.
- Choose the correct filler rod (and flux if required).
- Select a welding tip of adequate flame capacity for the thickness of material to be welded.
- Set the correct flame adjustment (paras. 4.5 and 4.6).

5.2 WELDING PROCESS. The process described in this section is fusion welding in which the portions to be joined are heated to their melting point. When the molten metal cools, it solidifies and forms a join between the two pieces of metal. Additional metal in the form of rods is added to the weld to build it up to the required level, which is slightly above the surface of the base metal.

The fusion welding of butt joints in metal plate is described here as this is a typical example of the welding process. Other applications of fusion welding, such as the attachment of metal plates to steel poles, welding of sections at various angles etc. are not included as the actual welding technique is similar to that used in the butt join and required only to be adapted to the particular situation.

5.3 PREPARATION OF EDGES. Where two pieces of metal plate are butted together for welding, the heat applied must penetrate the entire thickness of the metal for maximum strength. With square edged material up to 5 mm thick, this penetration can be obtained without difficulty and without excessive melting of the base metal being necessary. In this case a simple butt joint is satisfactory for welding (Fig. 17).

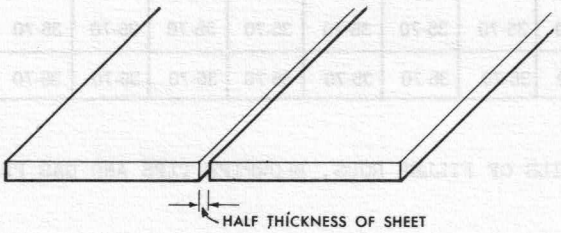


FIG. 17. BUTT JOINT IN METAL SHEET.

To obtain the necessary penetration in metal thicker than 5 mm the edges must be bevelled. This is called a "vee butt" joint. The method used to bevel the edges depends on the facilities available but the easiest method is by means of the oxy-acetylene cutting process described in Section 8. Fig. 18 shows a single-vee butt joint used for plate material 6 mm to 16 mm thick.

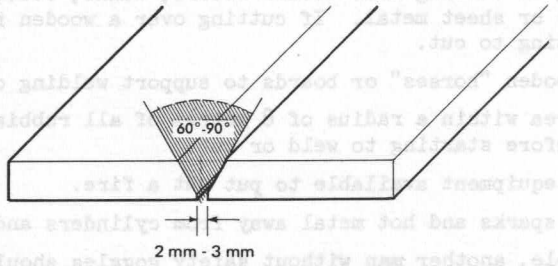


FIG. 18. SINGLE-VEE BUTT JOINT IN METAL PLATE.

Where welding can be performed on both sides of the plate, the double-vee butt weld has many advantages. (Fig. 19).

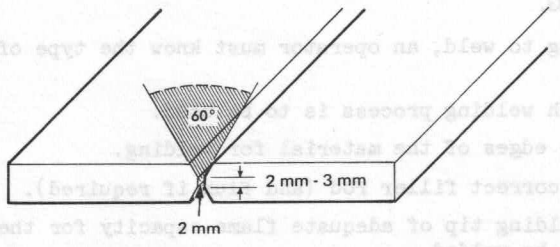


FIG. 19. DOUBLE-VEE BUTT JOINT.

5.4 FILLER ROD AND FLUX. Filler rods of similar material to that being welded are used to build up the weld to the required level. The diameter of the filler rod, which is governed by the thickness of the metal is shown in Table 1.

When fusion welding mild steel and wrought iron, flux is not required as oxidation does not occur when this material is heated. Metals that required flux for welding include stainless steel, aluminium, copper and brass.

Metal Thickness		1 mm	1.5 mm	2.5 mm	3 mm	4 mm	5 mm	6 mm	8 mm	10 mm	12 mm	15 mm
Filler Road Diameter		1.5 mm	1.5 mm	1.5 mm	2.5 mm	2.5 mm	3 mm	5 mm	5 mm	5 mm	6 mm	6 mm
Blowpipe Tip No.	OLD	1	2	3	4	4	5	6	7	7	8	9
	NEW	8	10	12	15	15	17	21	26	26	29	34
Pressures (kPa)	Acetylene	35-70	35-70	35-70	35-70	35-70	35-70	35-70	35-70	35-70	70-100	70-100
	Oxygen	35-70	35-70	35-70	35-70	35-70	35-70	35-70	35-70	35-70	200	200

TABLE 1. DETAILS OF FILLER RODS, BLOWPIPE TIPS AND GAS PRESSURES.

5.5 WELDING TIPS. Welding blowpipes are provided with a series of interchangeable tips of different sizes so that the same blowpipe can be used on a wide variety of operations. The size of tip to be used, which depends on the thickness of the metal to be welded, is shown in Table 1.

Tips are numbered according to size and may also carry a number indicating the particular blowpipe to which they are fitted and the fuel gas to be used. Older types of tips are numbered from 00 to 10 while newer types are numbered from 4 to 38. The new numbers indicate the diameter of the bore e.g. a No. 4 tip has a bore of 0.4 millimetres while a No. 38 tip has a bore of 3.8 millimetres. Table 1 shows the tip sizes in the old and new numbering.

5.6 WELDING METHODS. There are two welding techniques in general use for steel plate. They are the "forehand" and the "backhand" methods. In the forehand method the direction of welding is from right to left (assuming the welder is right handed). In the backhand method the weld progresses from left to right. The forehand method is used on plate up to 5 mm thick and the backhand method for material of greater thickness. The forehand method is more suitable for thin sheet because the operator has more control over the heat being supplied to the sheet edges and excessive melting can be avoided.

The backhand method has the advantage that the heat of the flame is more efficiently utilized which allows an increased welding speed, also in this method the operator is better able to see the progress of the weld.

EFFECT OF HEAT ON METAL. As the application of heat to metal causes expansion it is necessary to take precautions so that the metal will not become distorted during welding. The two pieces of metal to be welded must be placed slightly apart, for example, approximately 2 mm for a single-vee butt joint in 6 mm plate.

The pieces of metal should be "tack welded" at intervals of 150 mm-200 mm along the proposed joint to prevent buckling.

TACK WELDING. To make a tack weld:

STEP 1. Set up the equipment and fit a welding tip of the appropriate size (Table 1). Adjust the regulators to give pressures as in the table and light the blowpipe to give a neutral flame.

STEP 2. Hold the blowpipe so that flame makes an angle of about 60° to the work. The inner cone of the neutral flame should be positioned about 3 mm from the metal surface.

STEP 3. Play the flame over the plate at the right hand end of the vee so that an area of about 80 mm diameter is warmed. When this area reaches a red heat, concentrate the flame at the start of the vee. During this period, the end of the welding rod is warmed in the outer envelope of the flame so that it will be ready for use at the same time as the vee reaches the proper temperature.

STEP 4. When the metal under the flame at the end of the vee begins to glisten it is almost ready to melt. Bring the end of the welding rod down into the flame to raise it to a white heat.

STEP 5. As the edges of the vee begin to melt, add metal from the welding rod to bridge across the gap between the plates and from a single "puddle". The sides of the vee must be at a sufficient heat to fuse with the added metal right to the bottom of the vee. This is important, as the filler metal will cover the sides of the vee and prevent fusion if the metal is not properly heated.

STEP 6. Gradually increase the size of the welding puddle until it is about 10 mm diameter by adding more metal from the welding rod. It will be necessary to direct the flame a little more on the welding rod than the base metal to prevent the puddle becoming so fluid that it will run out of control. The end of the welding rod, kept in the puddle, can be used to move the puddle around a little. Always ensure that the metal over which the puddle is moved is ready for fusion.

Move the puddle around and build it higher at the right end by pressing the puddle back in that direction. Then let it move forward so that a small ledge at the back will cool slightly, and repeat the motion.

When the weld has been built up to about 2/3 thickness of the plate and about 12 mm long with a smooth, even contour the welding rod and flame should be removed from the welding puddle and the puddle allowed to solidify.

STEP 7. Make a similar tack weld at the left hand end of the job, and at intervals between, if required.

THE FOREHAND WELD. To make a forehand weld:

STEP 1. Remake the puddle at the right hand tack weld and add metal from the welding rod. During the welding the blowpipe must be moved through a series of arcs so that the flame plays first on one side of the vee and then on the other to prepare the plate edges for fusion (Fig. 20). During this movement the welding rod must be moved so that when the end is not in the puddle it is in the outer envelope of the flame. If the rod sticks to the work, move the blowpipe flame on to the tip of the rod and it will come away immediately.

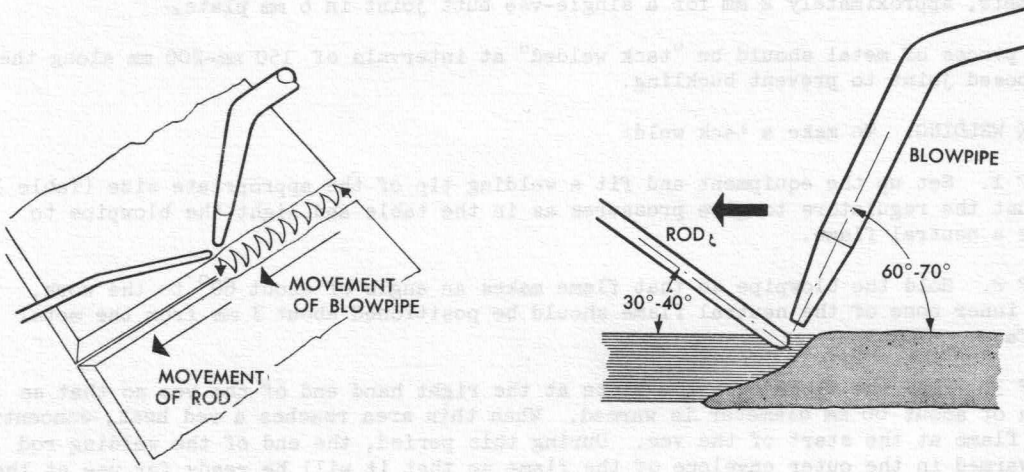


FIG. 20. FOREHAND WELDING TECHNIQUES.

STEP 2. Move the puddle down the face of the tack weld until it is almost at the bottom of the vee. Then concentrate the flame on the edges of the vee for about 12 mm in front of the puddle, raising the end of the welding rod out of the puddle but not out of the flame. As soon as the edges of the vee are ready to melt, add metal from the rod to fill in the bottom of the vee and bridge across the gap.

STEP 3. Return the rod to the puddle and move the puddle forward, building up the weld to about half the depth of the vee. Move the puddle back again to the face of the tack weld and over it to the start of the weld to build up the end of the weld slightly above the top of the vee. The puddle should be moved forward slowly, moving it slightly from side to side with the rod to fill up the weld to the desired level.

STEP 4. Return the puddle to the bottom of the vee and fill in another 12 mm at the bottom; then go back again and fill up the full depth of the weld as before. Repeat in this manner until the weld has progressed to within 6 mm of the second tack weld.

STEP 5. Concentrate the flame on the face of the second tack weld near the bottom of the vee until it is brought to a melting condition. Now heat the opening that is still left at the bottom of the weld until the entire area is ready to fuse with more molten metal from the rod. Re-establish the puddle by filling this opening to the required level.

STEP 6. As the end of the weld is reached, gradually reduce the size of the puddle by holding the flame a little further away until the full depth of the weld has been built up, then gradually draw the flame away altogether.

THE BACKHAND WELD. In this method the flame is directed at all times on the edges of the vee ahead of the welding puddle (Fig. 12) without the necessity for side to side motion of the blowpipe. This makes it possible to use a narrower angle of vee than is convenient with forehand welding. The method of backhand welding is as follows:

STEP 1. Starting at the LEFT HAND end of the vee, warm an area around the first tack weld and then raise it to the welding temperature. During this time the end of the welding rod should be held in the outer envelope of the flame as in the forehand method so that it will be ready to melt as soon as the puddle starts to form. Add metal from the rod into the puddle that is just forming on the surface of the tack weld, keeping the end of the welding rod in the puddle.

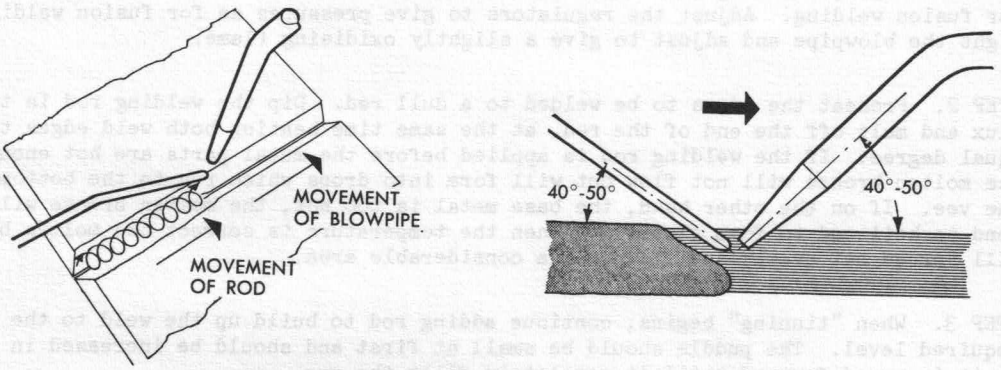


FIG. 21. BACKHAND WELDING TECHNIQUES.

STEP 2. In carrying on the welding, concentrate the flame a little more at the bottom of the vee and then move the puddle down to fill the vee. When this is done, concentrate the flame more on the welding rod and move the puddle upward again to fill the weld to the required level.

STEP 3. Continue the weld as described, filling in first a short section at the bottom of the vee and then working the puddle backward, adding metal so that the entire vee is filled. As in all welding, the edges of the vee in front of the puddle must be brought to the proper temperature before the puddle is allowed to flow forward onto them so that thorough fusion will take place.

STEP 4. Just before reaching the second tack weld, stop the welding action until the face of the tackwweld has been heated to fusion temperature, then restart the puddle at the bottom of the vee. Fill in the remaining part of the vee, gradually drawing the welding flame away as the vee is filled to the required level.

6. BRAZE WELDING.

6.1 Braze welding, (or bronze welding as it is often called), is a term which is applied to the joining of metals by a technique somewhat similar to fusion welding. The main difference between the two methods is that, in braze welding, the metal being welded is heated only to a dull red heat and is not intentionally melted as in fusion welding.

Braze welding can be used on cast iron, steel and aluminium and is particularly suitable for making repairs to cracked castings and for joining high melting point metals to alloys with low melting points.

6.2 PREPARATION FOR BRAZE WELDING. The joint design is similar to that used in fusion welding, that is, the parts to be welded are bevelled to give a vee joint. In the repair of cracks in castings, the crack is enlarged to a "vee" to give a larger bonding area for added strength.

6.3 FILLER RODS AND FLUX. The commonly used filler rod for cast iron and steel is manganese bronze. A flux is always used as the metal tends to oxidise during the process.

6.4 METHOD OF BRAZE WELDING. The method used is as follows:

STEP 1. Set up the equipment and fit a welding tip. The tip size depends on the particular job, but in general will be one to two sizes smaller than that recommended for fusion welding. Adjust the regulators to give pressures as for fusion welding. Light the blowpipe and adjust to give a slightly oxidising flame.

STEP 2. Preheat the edges to be welded to a dull red. Dip the welding rod in the flux and melt off the end of the rod, at the same time heating both weld edges to an equal degree. If the welding rod is applied before the metal parts are hot enough, the molten bronze will not flow but will form into drops which run to the bottom of the vee. If on the other hand, the base metal is too hot, the molten bronze will tend to boil and to form globules. When the temperature is correct the molten bronze will spread out evenly and flow over a considerable area.

STEP 3. When "tinning" begins, continue adding rod to build up the weld to the required level. The puddle should be small at first and should be increased in size as it is moved forward until it completely fills the vee.

7. BRAZING.

7.1 Brazing is a process of joining metals in which molten filler metal is drawn by capillary attraction into the space between closely adjacent surfaces of the parts to be joined. Usually the melting point of the filler metal is above 500°C. Brazing is not a fusion process that is, the metal being joined is not raised to fusion temperature.

Brazing is used mainly on small joints, tubes, flanges etc., and may be adapted to most metals and alloys. Fig. 22 shows typical joints that would be brazed. The design of these joints is such that only a thin film of filler metal is required. For this reason, brazing is not a welding process, but a "surface bonding" process, somewhat similar in principle to soldering. When silver alloy is used as filler metal, the process is known as "silver brazing" or "silver soldering". This process is often used on copper, stainless steel and nickel.

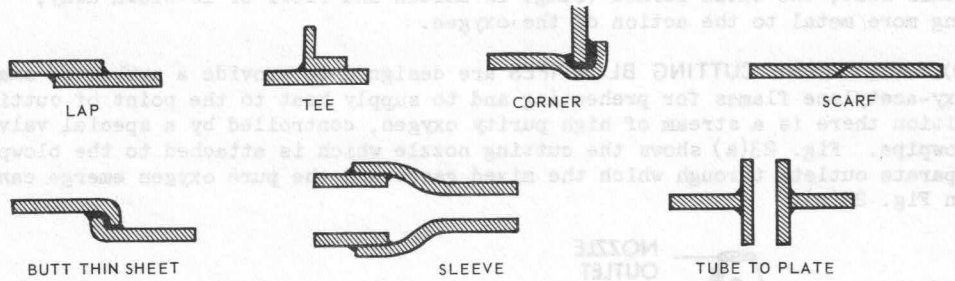


FIG. 22. TYPICAL BRAZED JOINTS.

7.2 PREPARATION. It is essential that the parts to be brazed should be free of grease, scale, oxides or other foreign matter. Cleaning can be carried out with a wire brush, emery cloth or by chemical means.

7.3 BRAZING ALLOY. This is the name given to the filler material: it may also be called brazing rod and is available in a range of non ferrous metals and alloys to suit the metals being brazed. These include copper alloys, nickel alloys and silver alloys and must conform to the requirements of particular jobs. They are made in a variety of forms such as wire, foil, sheet, strip and special shapes.

7.4 FLUX. A flux is used when brazing to prevent oxidation of the metals being joined. It is mixed to a paste and applied to both pieces of metal and the brazing rod.

7.5 METHOD OF BRAZING. The method used for brazing is somewhat similar to soldering with a blowpipe:

STEP 1. Set up the equipment and fit a small welding tip to the blowpipe. The tip used should be about two sizes smaller than would be used for fusion welding. Adjust the regulators to give equal pressures of 35-70 kPa. Light the blowpipe and adjust to give a soft neutral flame.

STEP 2. Apply the flux with a brush to both parts to be brazed, as well as the brazing rod or strip.

STEP 3. Using the outer envelope of the flame heat the parts to be joined, allowing the heat to play over the whole area of the joint. Continue heating just long enough to flow the alloy between the parts to be joined. Continue for the full length of the joint.

STEP 4. Allow the joint to cool and remove the excess flux.

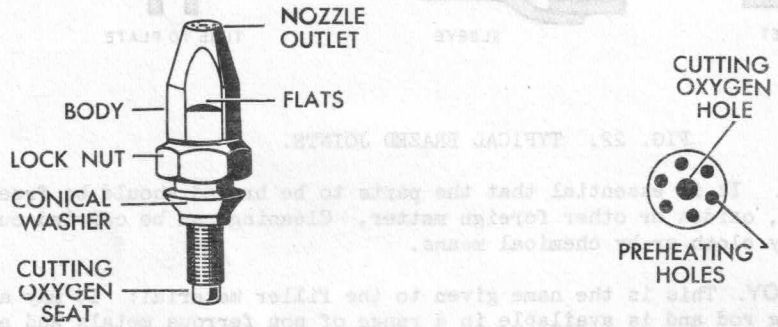
8. OXY-ACETYLENE CUTTING.

8.1 Oxy-acetylene cutting is a process for cutting iron and steel by using the rapid chemical reaction between heated iron and oxygen.

When the temperature of the iron or steel is raised until the metal is white hot and a stream of oxygen from the cutting blowpipe is directed on the white hot spot, the metal burns rapidly.

Under this heat, the oxide formed (slag) is molten and flows or is blown away, exposing more metal to the action of the oxygen.

8.2 OXY-ACETYLENE CUTTING BLOWPIPES are designed to provide a number of small oxy-acetylene flames for preheating and to supply heat to the point of cutting. In addition there is a stream of high purity oxygen, controlled by a special valve in the blowpipe. Fig. 23(a) shows the cutting nozzle which is attached to the blowpipe. The separate outlets through which the mixed gases and the pure oxygen emerge can be seen in Fig. 23(b).



(a) Cutting Nozzle. (b) End View of Outlet.

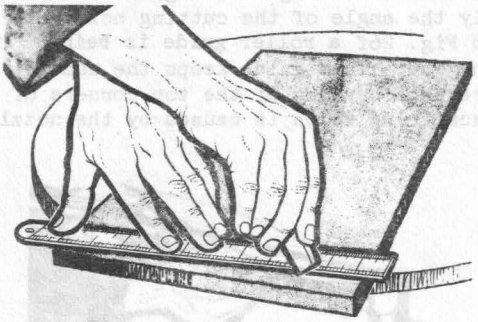
FIG. 23. CUTTING NOZZLE DETAILS.

8.3 CUTTING METHODS. Fig. 24 shows the preparation of the metal for cutting, the selection and checking of the nozzle and fitting the nozzle to the blowpipe. The nozzle sizes for various thickness of metal are in Table 2.

THICKNESS OF STEEL (mm)	CUTTING NOZZLE SIZE		REGULATOR PRESSURE		CUTTING SPEED mm/min.
	OLD	NEW	OXYGEN (kPa)	ACETYLENE (kPa)	
3	1	8	165	100	420
6	1	8	180	100	370
12	2	12	200	100	320
20	2	12	250	100	300
25	3	15	250	100	250
40	3	15	280	100	240
50	3	15	400	100	180
80*	3	15	500	100	150
100	4	20	500	100	130
120	4	20	520	100	120
160	5	24	550	100	110

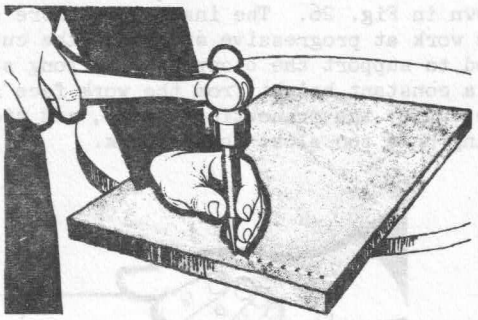
* *Recommended maximum thickness for cutting attachment.*

TABLE 2. DETAILS OF PRESSURES, NOZZLE SIZES AND SPEEDS FOR CUTTING MILD STEEL.



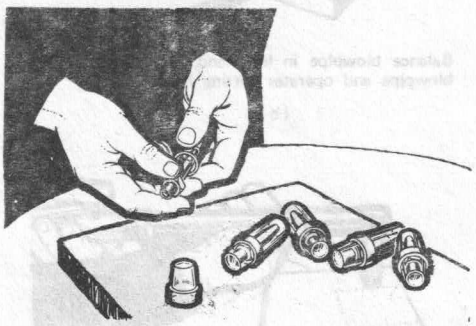
Clean surface thoroughly with wire brush. Mark line of cut with soapstone.

(a)



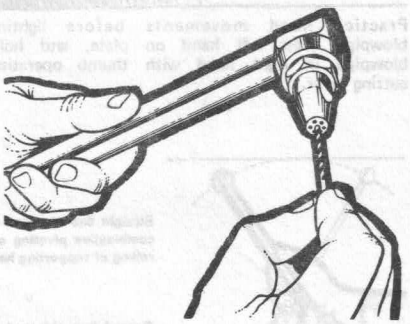
Make a punch mark every 5 mm along the line, as heat may destroy soapstone mark.

(b)



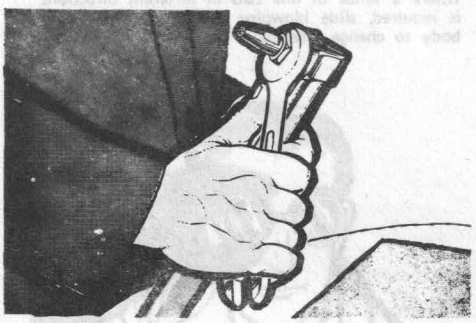
Select recommended cutting nozzle. When finished, return nozzle to container to prevent damage.

(c)



Check nozzle - face free of slag, no blockages in ports. Use only correct size drill to clean.

(d)



Insert nozzle in blowpipe head and tighten nut to ensure gas-tight fit.

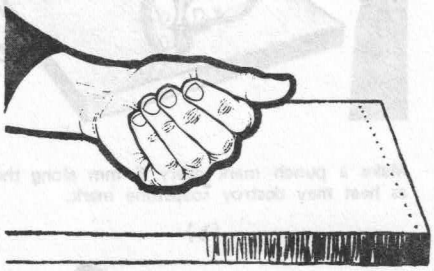
(e)

Place goggles on forehead ready to lower over eyes. Goggles protect eyes from sparks and rays of flame.

(f)

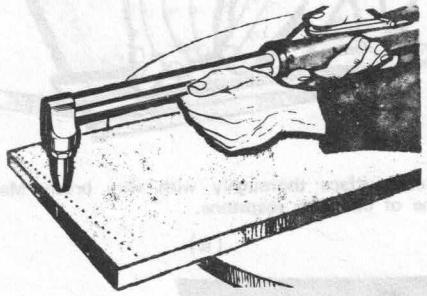
FIG. 24. OXY-ACETYLENE CUTTING - PREPARATIONS.

Fig. 25a, b, c and d illustrates hand movements that should be practised before starting to make a cut. Fig. 25e shows the method of adjusting gas pressures while Fig. 25f is a reminder of the use of protective clothing. At this stage the blowpipe is lit and a neutral flame is obtained. The method of making a straight cut is shown in Fig. 26. The inset shows more clearly the angle of the cutting nozzle to the work at progressive stages of the cut. In Fig. 26f a roller guide is being used to support the blowpipe on a long straight cut. This guide keeps the nozzle at a constant height from the work face and prevents burning of the top corners of the cut by the preheating flames, and stops backfiring which is caused by the nozzle being held too close to the work.



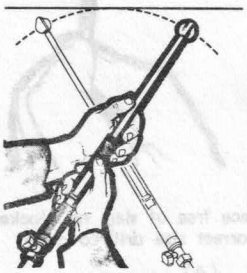
Practice hand movements before lighting blowpipe. Rest left hand on plate, and hold blowpipe in right hand with thumb operating cutting lever.

(a)



Balance blowpipe in left hand. Right hand guides blowpipe and operates cutting lever.

(b)

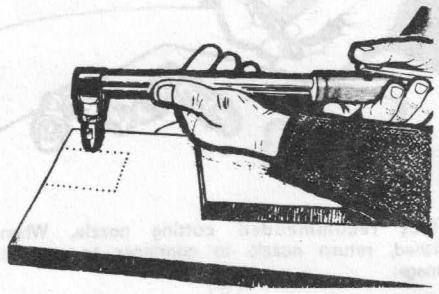


Straight line obtained by combination pivoting and rolling of supporting hand.

Curved line obtained by using supporting hand as pivot only.

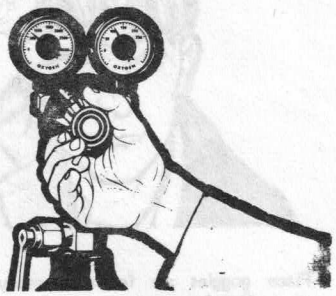
Using left hand as swivel, swing blowpipe from one side of plate to the other. Roll left hand as blowpipe is swivelled to overcome curve in line of cut.

(c)



Where a series of line cuts in different directions is required, slide blowpipe toward or away from body to change direction.

(d)



Open cylinder valves and adjust gauges to correct working pressures before lighting blowpipe.

(e)

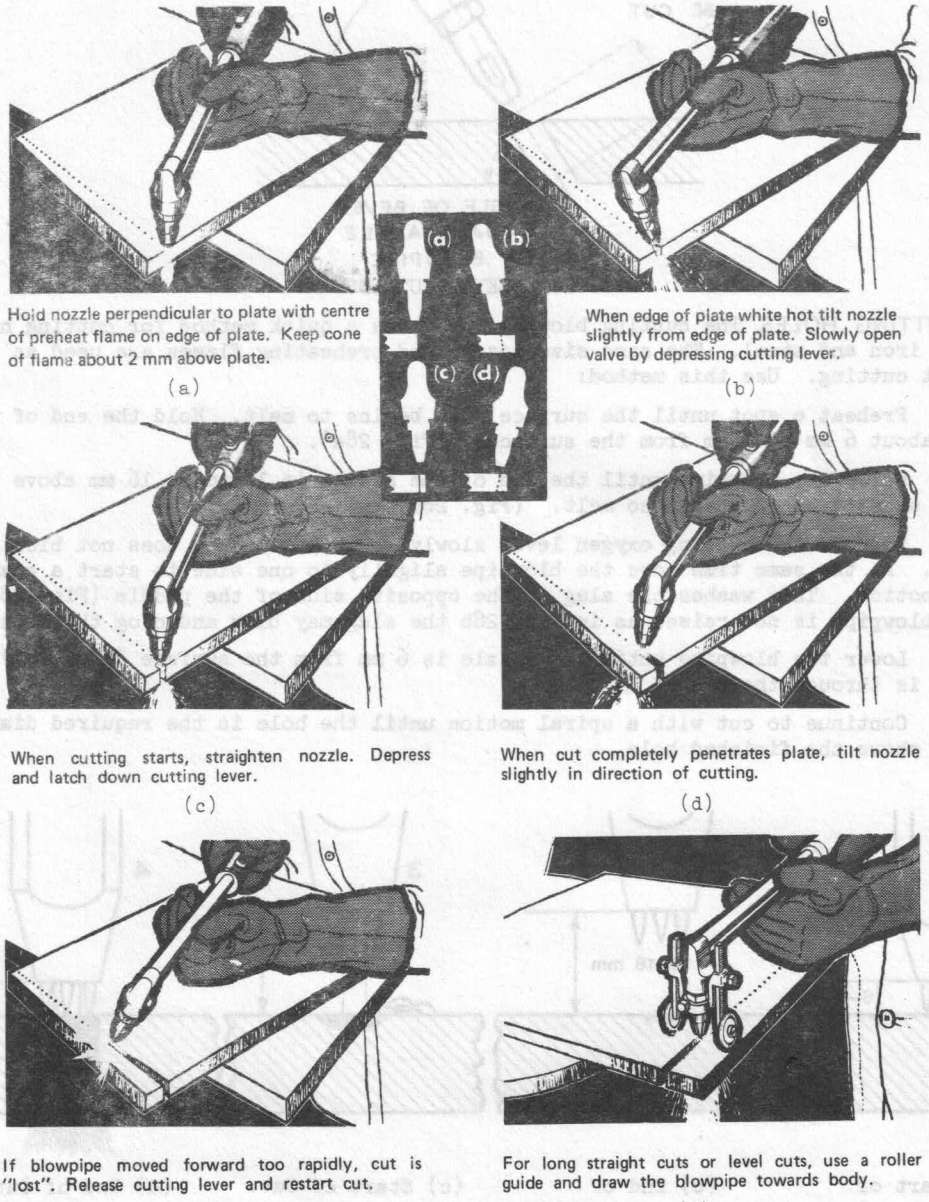
Rolling down sleeves and trouser cuffs will prevent sparks lodging in them. Put on gloves and goggles, light blowpipe and adjust preheating flame.

(f)

FIG. 25. OXY-ACETYLENE CUTTING - HAND MOVEMENTS.

8.4 If the blowpipe is moved forward too quickly the cutting action stops, and the cut is said to be "lost". Should this happen release the oxygen lever and restart the cut as before and at the position shown in Fig. 26(c). When restarting a "lost" cut, tilt the nozzle towards the part already cut. It helps to avoid an upward shower of sparks.

The beginner may find that after a plate has been cut, the two pieces still hold together. This is caused by the slag bridging across the bottom of the cut, and on cooling, holds the two sections. The slag is not serious and can be broken by a blow from a hammer.



Hold nozzle perpendicular to plate with centre of preheat flame on edge of plate. Keep cone of flame about 2 mm above plate.

(a)

When edge of plate white hot tilt nozzle slightly from edge of plate. Slowly open valve by depressing cutting lever.

(b)

When cutting starts, straighten nozzle. Depress and latch down cutting lever.

(c)

When cut completely penetrates plate, tilt nozzle slightly in direction of cutting.

(d)

If blowpipe moved forward too rapidly, cut is "lost". Release cutting lever and restart cut.

(e)

For long straight cuts or level cuts, use a roller guide and draw the blowpipe towards body.

(f)

FIG. 26. OXY-ACETYLENE CUTTING - METHOD.

8.5 For bevel cutting (Fig. 27) hold the blowpipe at the same angle as that required for the cut. REMEMBER that the thickness of a bevel cut is greater than the thickness of the metal and may required a different cutting speed, pressure and nozzle size to those required for a right angle cut.

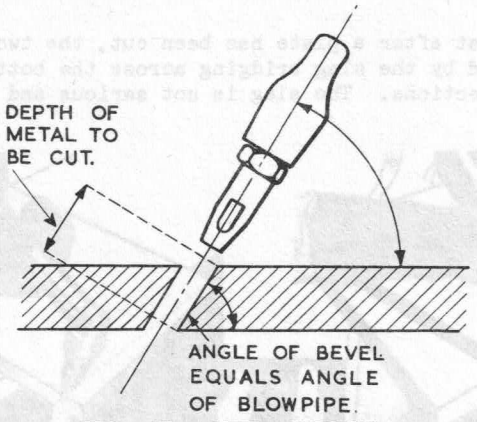


FIG. 27. BEVEL CUTTING.

8.6 CUTTING HOLES. The cutting blowpipe provides a quick method for cutting holes in iron and steel. The same size nozzle and preheating flames are used as for straight cutting. Use this method:

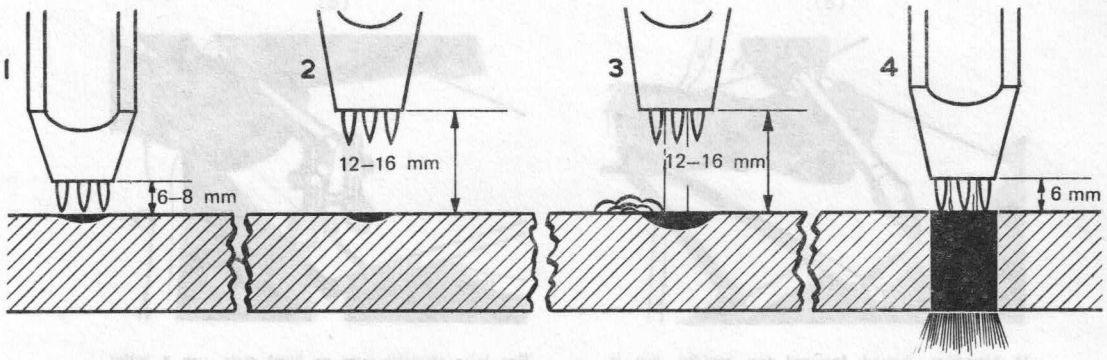
STEP 1. Preheat a spot until the surface just begins to melt. Hold the end of the nozzle about 6 mm to 8 mm from the surface. (Fig. 28a).

STEP 2. Raise the blowpipe until the end of the nozzle is 12 mm to 16 mm above the surface as soon as it starts to melt. (Fig. 28b).

STEP 3. Depress the cutting oxygen lever slowly so that the slag does not blow and scatter. At the same time move the blowpipe slightly to one side to start a small spiral motion. This washes the slag to the opposite side of the puddle (Fig. 28c). If the blowpipe is not raised as in Fig. 28b the slag may blow and clog the nozzle.

STEP 4. Lower the blowpipe until the nozzle is 6 mm from the surface (Fig. 28d) after the cut is through the plate.

STEP 5. Continue to cut with a spiral motion until the hole is the required diameter. Fig. 29 shows the finished hole.



(a) Start of preheating. (b) End of preheating. (c) Start of Cut. (d) End of Cut.

FIG. 28. CUTTING A HOLE.

If a larger hole is required mark the size of the hole on the surface. Pierce a hole at some point inside the outline. Start the cut at this point and work towards the marked line (Fig. 30), then follow the line until the section is removed.

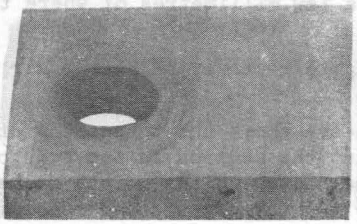


FIG. 29. COMPLETED HOLE.

FIG. 30. CUTTING A LARGER HOLE.

8.7 CUTTING PIPE. Make a square cut as follows:

STEP 1. Support the pipe so that it can be easily turned.

STEP 2. Mark a line at the point of the cut.

STEP 3. Pierce a hole halfway down one side (Fig. 31) and cut along the line to the top of the pipe.

STEP 4. Give the pipe a quarter of a turn so as to bring the finishing position back to the starting position and continue the cut until the top of the pipe is reached again.

STEP 5. Give the pipe another quarter turn and continue in this way until the cut is complete.

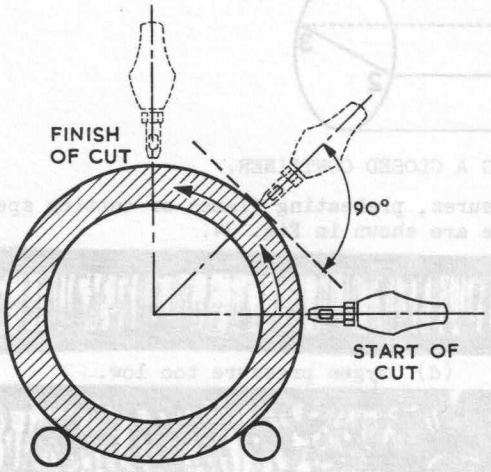


FIG. 31. CUTTING PIPE.

8.8 WHEN CUTTING HEAVY SECTIONS of metal the important factor is the starting of the cut (Fig. 32). One method is to cut a slot in the bottom edge of the material.

This reduces the cross-sectional area of the material and allows the cut to get well under way before reaching the maximum thickness.

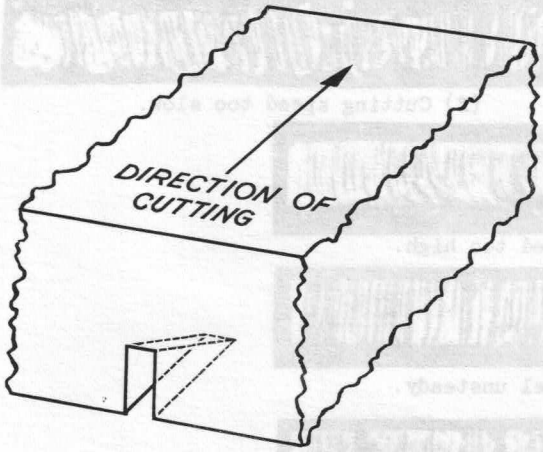


FIG. 32. STARTING A HEAVY CUT.

8.9 CUTTING A CONTAINER. Take these precautions before cutting a container:

- Clean it out thoroughly before applying heat.
- Fill the container with water to within a few millimetres of where the cut is to be made.
- Make sure that there is a vent or opening to release the heated air from the container.

Cut around the container as shown in Fig. 33 but leave short uncut sections at each corner and one in the centre of each side. Then cut the section in the body of the container marked 1; next cut away two of the corners such as the points marked 2 and 3; the small section at point 4 is then cut; the two corners 5 and 6 remain to be cut. Should the container collapse at this stage it will occur in front of the operator.

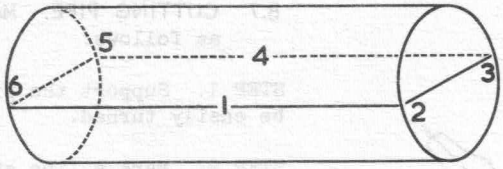


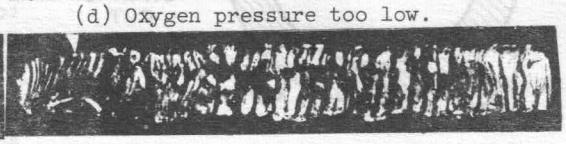
FIG. 33. METHOD OF CUTTING A CLOSED CONTAINER.

8.10 CUTTING FAULTS. Incorrect oxygen pressures, preheating flames or cutting speed are common faults in hand cutting. These are shown in Fig. 34.

(a) Good cut.

(d) Oxygen pressure too low.

(b) Preheating flames too small.



(e) Oxygen pressure too high.

(c) Preheating flames too long.

(f) Cutting speed too slow.

(g) Cutting speed too high.

(h) Blowpipe travel unsteady.

(i) Lost cut not properly restarted.

FIG. 34. CUTTING FAULTS.

Some of the effects of bad cutting are noticeable on the top surface of the metal being cut. Three of these faults are shown in Fig. 35.

(a) Cutting speed too high.

(b) Blowpipe travel unsteady.

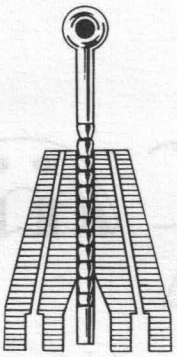
(c) Lost cut not properly restarted.

FIG. 35. TOP VIEW OF TYPICAL FAULTS.

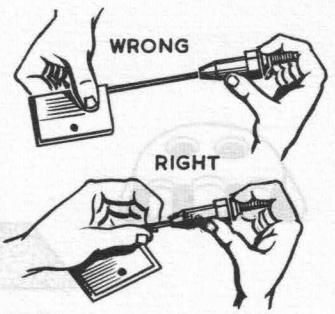
9. RECONDITIONING NOZZLES AND TIPS.

9.1 To keep nozzles and tips in good condition they should be stored in a container when not in use.

Use nozzle cleaners (Fig. 36a) to clean both the preheat and cutting oxygen holes in cutting nozzles. They are designed to give a cleaning and polishing action. Fig. 36(b) shows the method of using the cleaner by gripping it close to the nozzle face.



(a) Cleaner in nozzle.



(b) Method of using cleaner.

FIG. 36. USING NOZZLE CLEANER.

If the blockage remains, use a cleaning drill of the size shown in Table 3. Work the drill up and down carefully in the holes but do not twist it. If the drill does not enter the hole easily, do not force it. Start with a drill two sizes smaller and work up to the correct size. Table 3 also gives the drill sizes to be used with welding tips. In this table the old and new sizes are shown for each tip or nozzle.

TIP SIZE		CLEANING DRILLING NO.	TIP SIZE		CLEANING DRILLING NO.
NEW	OLD		NEW	OLD	
4	00	4 (78)*	20	–	20 (47)*
6	0	6 (73)*	21	6	21 (45)*
8	1	8 (67)*	26	7	26 (38)*
10	2	10 (61)*	29	8	29 (32)*
12	3	12 (56)*	32	–	32 (31)*
15	4	15 (53)*	34	9	34 (29)*
17	5	17 (51)*	38	10	38 (25)*

(a) Welding tips.

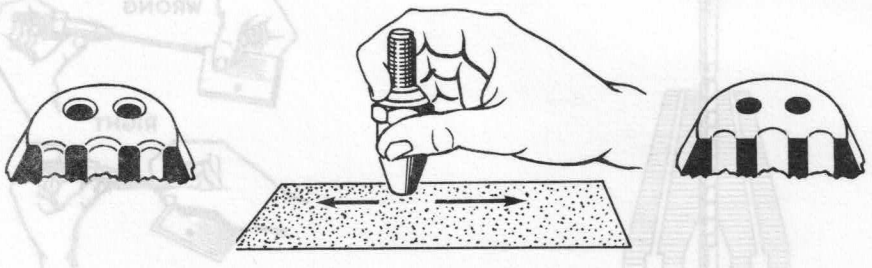
NOZZLE SIZE		CLEANING DRILL NO.	
NEW	OLD	PREHEAT HOLES	OXYGEN HOLES
6	0	5(77)*	6 (73)*
8	1	6 (73)*	8 (67)*
12	2	7 (70)*	12 (56)*
15	3	8 (67)*	15 (53)*
20	4	10 (61)*	20 (47)*
24	5	11 (58)*	24 (38)*
32	6	12 (56)*	32 (31)*

(b) Cutting nozzles.

* *Figures in brackets indicate standard twist drill sizes.*

TABLE 3. DRILL SIZES FOR CLEANING NOZZLES AND TIPS.

9.2 After a period of use the holes in the cutting nozzle become bellmouthed (Fig. 37a). This can be corrected by rubbing the nozzle with long regular strokes on emery cloth (Fig. 37b). The result should be a nozzle with sharp edged holes and a flat, clean face (Fig. 37c).



(a) Bellmouthed. (b) Cleaning. (c) Cleaned.

FIG. 37. REFACING "BELLMOUTHED" CUTTING NOZZLE.

10. TEST QUESTIONS.

1. *What are the differences between an oxygen and an acetylene cylinder?*
2. *What is meant by "fusion" welding?*
3. *List the precautions to be taken when handling gas-filled cylinders.*
4. *What is the function of the regulator?*
5. *Describe briefly the operation of an inverse acting regulator.*
6. *List four ways of preventing damage to regulators.*
7. *Sketch the mixer of an equal pressure blowpipe.*
8. *Describe the procedure to be followed when setting up the oxy-acetylene equipment.*
9. *How would you test the equipment for leaks after connecting a new cylinder?*
10. *Describe the procedure that must be followed when obtaining the correct pressures of oxygen and acetylene for a job.*
11. *How would you obtain a neutral flame:*
    (i) on an equal pressure blowpipe with a welding tip fitted, and
    (ii) on a cutting blowpipe?
12. *What is an oxidising flame?*
13. *If a "flashback" occurs in the blowpipe what action would you take?*
14. *List the steps to be carried out when closing down the equipment at the end of the job.*
15. *What joint preparation is necessary when butt welding 10 mm steel plate?*
16. *When is "forehand" welding used in preference to the "backhand" method?*
17. *Why are "tack" welds necessary?*
18. *In what way does a "braze" weld differ from a "fusion" weld?*
19. *Is "brazing" a true welding process?*
20. *Describe briefly the principle of the oxy-acetylene process.*
21. *Show by a sketch the arrangement of holes in the cutting nozzle.*
22. *What causes a cut to be "lost"?*
23. *List the protective clothing and equipment that must be worn when using the oxy-acetylene equipment.*
24. *Give four precautions that must be taken to prevent fire from spark or pieces of hot metal.*
25. *What treatment would you give an enclosed container before starting to cut or weld it?*
26. *What equipment is used for cleaning cutting nozzles?*
27. *What treatment would you give a cutting nozzle that has become "bellmouthed"?*
28. *Where should the cylinder key be placed when the equipment is in use?*

END OF PAPER.

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